Comparison of anesthetic efficacy of 4% articaine and 2% lidocaine for maxillary buccal infiltration in patients with irreversible pulpitis

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Objective. The purpose of this prospective, randomized, double-blind study was to compare the anesthetic efficacy of 4% articaine and 2% lidocaine (both with 1:100,000 epinephrine) for buccal infiltration in patients experiencing irreversible pulpitis in maxillary posterior teeth.
Study design. Forty patients with irreversible pulpitis in first premolar or first molar were divided into 4 study groups and received buccal infiltration of either 4% articaine or 2% lidocaine in a double-blind manner. Endodontic access was begun 5 minutes after solution deposition. Success was defined as no or mild discomfort (VAS recordings) during the endodontic procedure.
Results. The success rate for maxillary buccal infiltration to produce pulpal anesthesia using articaine was 100% in first premolar and first molar, and for the lidocaine solution, success rate was 80% in first premolar and 30% in first molar. There was high significant difference between the articaine and lidocaine solutions (ANOVA; $P < .001$).
Conclusion. The efficacy of 4% articaine was superior to 2% lidocaine for maxillary buccal infiltration in posterior teeth. **(Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009;107:133-136)**

Adequate local anesthesia is essential for successful patient management in endodontic therapy. A range of local anesthetic drugs have been used in dentistry among which lidocaine is the most popular. Articaine was introduced in April 2000 in the United States[1] and it is most commonly used dental anesthetic in Germany, Italy, The Netherlands, and Canada.[2]

Articaine is classified as an amide and contains a thiophene ring instead of a benzene ring like other amide local anesthetics.[1] A second molecular difference between articaine and other amide local anesthetics is the extra ester linkage incorporated into the articaine molecule,[1] which results in hydrolysis of articaine by plasma esterases. Isen[3] states that 90% to 95% of articaine is metabolized in the blood, whereas only 5% to 10% is broken down in the liver.

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Articaine, a safe local anesthetic,[1] has a reputation of providing an improved local anesthetic effect. Several previous studies reported no significant difference in the anesthetic efficacy between 4% articaine and 2% lidocaine when used for primary inferior alveolar nerve block, intraligamentary injection, supplementary injection, or infiltration injection.[1,4-10] However, one study suggested that although articaine and lidocaine did not differ significantly in providing successful pulpal anesthesia for maxillary canines, the former seemed to provide longer duration.[11] Kanaa et al.[12] and Robertson et al.[13] found that 4% articaine with 1:100,000 epinephrine was more effective than 2% lidocaine with 1:100,000 epinephrine in producing pulpal anesthesia in lower molars after buccal infiltration.

Interestingly, a recent study conducted by Corbett et al.[14] showed that efficacy of 4% articaine infiltration for mandibular first molar was similar to inferior alveolar nerve block (IANB) using 2% lidocaine over a 30-minute study period. Jung et al.[15] compared the anesthetic efficacy of IANB with that of buccal infiltration in mandibular molars. They found that buccal infiltration of 4% articaine was a useful alternative to IANB.

Most of these studies investigated the efficacy of articaine in mandibular posteriors. Nevertheless, the anesthetic efficacy of articaine in providing pulpal anesthesia for maxillary posterior teeth with irreversible pulpitis needs further investigation. Therefore, the purpose of this prospective, randomized, double-blind study was to compare the anesthetic efficacy of 4%

Table I. Study groups

Groups	No. of patients	Tooth type	Anesthetic used
I	10	First premolar	1.7 mL of 4% articaine
II	10	First molar	1.7 mL of 4% articaine
III	10	First premolar	1.7 mL of 2% lidocaine
IV	10	First molar	1.7 mL of 2% lidocaine

articaine and 2% lidocaine for buccal infiltration in patients experiencing irreversible pulpitis in maxillary posterior teeth.

MATERIALS AND METHODS

Forty adult patients aged between 18 and 40 years participated in this study. These 40 patients were selected in such a way that 20 patients had irreversible pulpitis in maxillary first premolar and remaining 20 patients had irreversible pulpitis in the maxillary first molar. All were emergency patients of Tamilnadu Government Dental College and Hospital, Chennai, and were in good health as determined by a health history questionnaire and verbal questioning. Ethical approval was obtained and all participants were provided informed, written consent.

To qualify for the study, each patient had a vital maxillary posterior tooth (first molar or first premolar), was actively experiencing pain, and had a prolonged response to cold testing with Endo-Ice (1,1,1,2 tetrafluoroethane, Hygenic Corp., Akron, OH). Patients with no response to cold testing, periradicular pathosis (other than a widened periodontal ligament), or no vital coronal pulp tissue on access were excluded from the study. Therefore, each patient had a tooth that fulfilled the criteria for a clinical diagnosis of irreversible pulpitis.

Each patient rated his or her initial pain on a 10-cm Visual Analogue Scale (VAS) with end points tagged no pain (0 cm) and unbearable pain (10 cm). These 40 patients were randomly divided into 4 study groups as shown in Table I.

Under sterile conditions, the following procedure was carried out. Topical anesthetic gel 2% lidocaine (xylocaine jelly, AstraZeneca, India) was passively placed at the infiltration site for 60 seconds using a cotton-tip applicator. A single operator gave all local anesthetic injections using standard dental aspirating syringe fitted with a 27-gauge, 1.5-inch needle and this operator had no involvement with testing the outcome. The target site was centered over the buccal root apex of the maxillary first premolar or between mesiobuccal and distobuccal root apices of the maxillary first molar. The needle was gently inserted into the height of the mucobuccal fold, with the bevel facing the alveolar bone and advanced until the bevel was at or above the apex of the tooth to be anesthetized. After needle penetration toward the target site, aspiration was performed and anesthetic solution was deposited at the rate of 1 mL/min. Group I and group II received 1.7 mL of 4% articaine with epinephrine 1:100,000 (Septanest, Septodont, France), group III and group IV received 1.7 mL of 2% lidocaine with epinephrine 1:100,000 (xylocaine 2% with epi 1:100000).

At 5 minutes post injection, under rubber dam isolation, an investigator performed access cavity and determined the anesthetic efficacy. All the patients and investigator were blinded to the type of anesthetic solution used. Patients were instructed to rate definitively any pain felt during the endodontic procedure. If the patient felt pain, the treatment was immediately stopped and the patient rated his or her discomfort using the 10-cm VAS. The success of the technique was defined as the ability to access and instrument the tooth without pain or mild discomfort (VAS score of 0 or 1). The VAS scores are presented in Table II.

Comparisons of anesthetic success among the 4 groups were analyzed using 1-way analysis of variance (ANOVA) followed by Tukey's HSD post-hoc test. The differences in age and initial pain were analyzed using 1-way ANOVA, whereas chi-square test was used to determine differences in gender among the groups. Comparisons were considered significant if P was less than .05.

Table II. VAS pain ratings for patients during endodontic procedure:

Group I	Group II	Group III	Group IV
0	0	1	3
0	0	5	0
0	0	0	0
0	0	2	7
0	1	0	3
0	0	0	2
1	0	1	6
0	0	0	8
0	0	1	5
0	0	0	0

RESULTS

The age, gender, and initial pain are presented in Table III. There were no significant differences among the 4 groups.

Anesthetic success is presented in Table IV. The success rate for the maxillary buccal infiltration to produce pulpal anesthesia in irreversible pulpitis using articaine solution was 100% for the first premolar and

Table III. Initial values for the 4 groups

	4% Articaine		*2% Lidocaine*		
Value	*Group I*	*Group II*	*Group III*	*Group IV*	*P value**
Age, y†	29.4 ± 6.72 Range 19-40	29.60 ± 7.01 Range 18-40	29.1 ± 6.35 Range 20-37	29.3 ± 6.96 Range 19-39	.998
Gender	4 F 6 M	5 F 5 M	5 F 5 M	6 F 4 M	.849
Initial pain‡	6.5 ± 1.43	6.4 ± 1.43	6.7 ± 1.42	6.6 ± 1.26	.967

F, female; M, male.
*There was no significant difference ($P > .05$) among the 4 groups.
†Mean ± SD
‡Mean ± SD, VAS Ratings in cm.

Table IV. Percentages and number of patients who achieved anesthetic success with maxillary buccal infiltration using articaine and lidocaine solutions for first premolar and first molar

	4% Articaine	*2% Lidocaine*	*P value One-way ANOVA*
First premolar	100% (10 of 10) Group I	80% (8 of 10) Group III	.641
First molar	100% (10 of 10) Group II	30% (3 of 10) Group IV	.001*

*There was high significant difference between articaine and lidocaine solution.

first molar, and for the lidocaine solution, the anesthetic success was 80% in first premolar and only 30% in first molar**.** The ANOVA indicated a statistically significant difference among the groups ($P < .001$). Therefore, the data were further analyzed using the Tukey's HSD test, which indicated a statistically significant increase in VAS scores of group IV compared with the other 3 groups.

DISCUSSION

The patient's age, gender, and initial pain were not significantly different among the 4 groups (Table III). Therefore, the effect of age, gender, and initial pain would be minimized among these 4 groups. The mean initial pain rating of around 6.5 cm (Table III) in all the groups represent patients with an irreversible pulpitis who present for emergency treatment.

Multiple comparison reveals that the 4% articaine did not statistically improve the anesthetic success of maxillary buccal infiltration compared with 2% lidocaine in patients with irreversible pulpitis in first premolar ($P = .641$) (Groups I and III). Nevertheless, in the case of the first molar, there exists a high significant difference ($P = .001$) (Groups II and IV) between the two anesthetic solutions (Table IV).

Recently, Evans et al.[16] evaluated the anesthetic efficacy of 4% articaine and 2% lidocaine (both with 1:100,000 epinephrine) in the maxillary lateral incisor and first molar. They found that articaine exhibited a significantly higher success rate than lidocaine in maxillary lateral incisors. We found greater success in obtaining anesthesia in the first premolar and first molar with articaine.

Maxillary first premolar and first molar sites may differ with respect to cortical bone thickness and width of alveolar bone, thereby possibly affecting the success of infiltration approaches.[8] The mechanism of reversible nerve conduction block by articaine is similar to that of other amide local anesthetics.[17] However, articaine is unique among them, because it contains a thiophene group, which increases its lipid solubility. Lipid solubility determines to what degree the molecules penetrate nerve membranes. Therefore, articaine diffuses better through soft tissues than do other anesthetics,[17] thereby achieving higher intraneural concentration, more extensive longitudinal spreading, and better conduction blockade.[18] In our study, the lack of success with 2% lidocaine in the first molar may be attributable to lower diffusibility of anesthetic solution to encompass all the roots of first molar, because of wider alveolar bone in the molar region compared with the premolar region.

The lower concentration of lidocaine (2%) compared to articaine (4%) may also be a reason for inadequate anesthesia. Oertel et al.[19] determined the concentration of 4% articaine and 2% lidocaine in alveolus blood using high-performance liquid chromatography. Blood samples were collected from the alveolus of upper molars 2 to 14 minutes after submucous injection of 4% articaine and 2% lidocaine (2 mL each). They postulated that higher blood levels found for articaine in alveolus blood compared to lidocaine was because of higher concentration of the drug in the injection solution.

Potocnik et al.[20] in an in vitro study concluded that 2% and 4% articaine is more effective than 2% and 4%

lidocaine or 3% mepivacaine in depressing the compound action potential of the A fibers in the isolated rat sural nerve. In addition, the thiophene derivative (carticaine) blocks ionic channels at lower concentrations than the benzene derivative (lidocaine).[21] Hence, future studies should be aimed at comparing the efficacy of 2% articaine and 2% lidocaine.

Within the limitations of the low sample size, we conclude that 4% articaine with 1:100,000 epinephrine was more effective than 2% lidocaine with 1:100,000 epinephrine in producing pulp anesthesia in maxillary posterior teeth with irreversible pulpitis, after buccal infiltration.

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